THE VALUE OF INFORMATION ABOUT CHILD CARE QUALITY

Hilde Patron, Louisiana Tech University

ABSTRACT

The quality of child care arrangements such as day care centers is very important to parents, and quite possibly to society in general. Unfortunately, quality can vary significantly from center to center, and can be rather difficult to asses. Parents therefore have to make child care choices without fully understanding the quality of care their children will receive. In this paper I show that a rational, quality-conscious parent always values and is therefore willing to buy information about the quality of day care arrangements.

INTRODUCTION

According to the U.S. Census Bureau [13], in 1997, 12.4 million (63%) preschoolers (children ages 0-5) spent part of their time in some kind of child care arrangement. These arrangements can vary significantly in terms of group size, adult to child ratio, motivation, energy, training and experience of the provider, complaints issued to licensing agencies, and location, among other things, making parents' child care choices very difficult.

Parents can ameliorate their uncertainty to make better informed choices by visiting establishments and gathering information about their quality. Mocan [9] however has shown through the use of surveys conducted in 1993 in California, Colorado, Connecticut, and North Carolina, that it may be difficult for parents to differentiate high and low quality care. Nevertheless, and given that parents report that the quality of day care arrangements is important to them (Mocan [9]), they have the option of consulting (sometimes at a fee) with child care resource and referral agencies (henceforth R&R) which can provide information about child care alternatives and quality features. According to the US National Association of Child Care Resource and Referral Agencies [10], the number of referrals and other related consultations in the year 2000 was estimated to be 5.1 million.

In this paper I develop a formal model to study the value of information to parents about the quality of child care arrangements. The model can be thought of as an optimal pricing model for R&R consultations. Although this paper focuses on information issues, the basic model is similar to the women labor supply models of Blau and Hagy [2], Michalopoulos, Robins, and Garfinkel [6], and Ribar [11] among others, in which a parent, typically the mother, simultaneously decides how much time she spends at a paid job and how much time she spends caring for her child. I take this type of model a step further by estimating the value of information to parents of child care quality. I find that for very general utility functions, full or partial information about the quality of child care arrangements is always valuable.[1] This confirms theoretically the intuitive empirical results from surveyed parents reported by Mocan [9].

The rest of the paper is organized as follows. In the next section, the basic model is developed. In this model the mother has only one child care alternative and is uncertain about its quality. Later, the value of information about child care quality is estimated, and shown to be positive. I then extend the model to allow the mother to choose among two child care alternatives, both of unknown quality, and I show that the value of information about multiple child care arrangements is also positive. At last, I conclude and discuss extensions of this work.

THE MODEL

The model developed in this section incorporates elements and terminology from Blau and Hagy [2], Michalopoulos, Robins, and Garfinkel [6], and especially from Ribar [11]. The novelty of the model is the way in which quality of care is specified. The model considers the mother of a small child who is endowed with 16 hours of time and has to decide how many hours to spend working at a paid job and how many hours to spend in pleasurable activities. While she is working, the mother leaves her child in the only child care arrangement available. While she is not working, she takes care of her child. Finally and for tractability purposes, assume that the decision to work and the labor income of other members of the household are predetermined and are thus taken as given.

The mother derives utility from the quality of child care (*Q*), leisure (*L*), and a composite consumption good (*G*) with unitary price. The mother's utility is represented by a non-negative, increasing, strictly concave, and differentiable utility function, $U(Q,L,G)$.

The quality of child care is determined by the number of maternal child care hours (T) and non-maternal child care hours (F). More specifically, assume that quality of child care is given by $Q = \alpha_T T + \alpha_F F + \varepsilon$, where α_T and α_F are positive productivity parameters such that $\alpha_i \in [0,1]$ $i = T, F$.[2] Assume that α_T is known but that α_F is not. Furthermore, for tractability purposes, assume that $\alpha_F \in \left\{\overline{\alpha_F}, \underline{\alpha_F}\right\}$, where $\overline{\alpha_F}$ represents high quality care and $\underline{\alpha_F}$ represents low quality care. Hence, assume that $\overline{\alpha_F} > \underline{\alpha_F}$. Finally, let $\rho \in (0,1)$ denote the mother's subjective prior belief that $\alpha_F = \overline{\alpha_F}$.

The term ε represents a random unobserved productivity component with density $f(\varepsilon)$ on a positive set E. The random component ε is never observed, and it is not verifiable. Hence, Q is never known with certainty.

The mother's maximization problem is subject to one budget constraint and four time constraints. The budget constraint states that all money earned by her from her job plus all non-labor income is spent in the composite good (with unitary price) and in child care fees, $G + P_F F = WH + Z$, where P_F is the price of one hour of non-maternal care, W is the hourly wage rate, H is the number of hours the mother devotes to paid work, and Z is other income in the household.

The time constraints are that the mother is only endowed with 16 hours that can be devoted to work and leisure, $H + L = 16$; that the child must be cared for at all times, $T + F = 16$; that the mother spends all of her leisure time caring for her child, $L = T$; and that while at work the child is placed in a child care arrangement, $F = H$.

Combining all of the assumptions and constraints, the mother's maximization problem can be written (in terms of F) as follows,

$$\underset{F}{Max}\ E_\rho U(F,\alpha_F,\varepsilon) = \rho\,\tilde{U}(F,\overline{\alpha_F}) + (1-\rho)\,\tilde{U}(F,\underline{\alpha_F}), \qquad (1)$$

where E_ρ denotes the expectations operator given beliefs ρ and where

$$\tilde{U}(F,\alpha_F) = \int_{\mathrm{E}} U\left(\alpha_T(16-F) + \alpha_F F + \varepsilon, 16-F, (W-P_F)F + Z\right) f(\varepsilon)d\varepsilon\,. \qquad (2)$$

Let $F^*(\rho)$ denote the number of hours the mother chooses to work and to place her child in a non-parental child care arrangement and let $V(\rho)$ denote the expected utility she derives from this decision, i.e. $V(\rho) = E_\rho U(F^*(\rho),\alpha_F,\varepsilon)$. Given curvature assumptions $F^*(\rho)$ exists and it is a unique maximum.

THE VALUE OF INFORMATION ABOUT CHILD CARE QUALITY

Although the mother's maximization problem (1) does not have a closed form solution, it can nevertheless be used to gain some understanding about the "price" that the mother is willing to pay to learn about the quality of the child care arrangement. Assume that prior to choosing how many hours to work and to place her child in a non-parental arrangement, the mother can make an appointment with an R&R. Also assume (for now) that the R&R can fully eliminate the uncertainty about child care quality. How much is the mother willing to "pay" for this service? To answer this question note that if the mother finds out that the true quality of the child care arrangement is given by $\overline{\alpha_F}$, then she chooses $F^*(1)$ and expects utility $V(1)$. Ex-ante she expects this to happen with probability ρ. If, alternatively, the mother learns that the true quality is given by the productivity parameter $\underline{\alpha_F}$, then she chooses $F^*(0)$ which yields expected utility $V(0)$. If $\rho V(1) + (1-\rho)V(0) > V(\rho)$, then the mother makes the appointment with the R&R, and is willing to "pay" up to $VI = \rho V(1) + (1-\rho)V(0) - V(\rho)$ for this information.

Proposition 1: The expected value to the parent of full information is positive, that is $VI > 0$.

Proof: If the mother learns that $\alpha_F = \overline{\alpha_F}$, then she chooses $F^*(1)$ and derives expected utility $V(1)$. Given strict concavity of U, $\forall \rho \neq 1$ $V(1) > \tilde{U}(F^*(\rho), \overline{\alpha_F})$.[3] Similarly, if the mother learns that $\alpha_F = \underline{\alpha_F}$, she chooses $F^*(0)$ and expects utility $V(0)$. Given strict concavity of U, $\forall \rho \neq 0$ $V(0) > \tilde{U}(F^*(\rho), \underline{\alpha_F})$.[4] Hence, $\forall \rho \in (0,1)$

$$\rho V(1) + (1-\rho)V(0) > \rho \tilde{U}(F^*(\rho), \overline{\alpha_F}) + (1-\rho)\tilde{U}(F^*(\rho), \underline{\alpha_F}) = V(\rho).$$

Although it may be possible for parents to learn a lot about child care quality features by consulting with an R&R expert, there are some intrinsically unobservable characteristics about these arrangements, such as the energy and motivation of the provider for example, that may preclude even experts from making perfect inferences. In the remainder of this Section, I study whether partial information is also valuable to parents.

The notion of information that I have in mind is defined by Blackwell (1953).[5] In particular, let *g* denote an information structure for the quality of child care α_F. Then *g* is defined by the set of probabilities

$$\left\{ g(\overline{\alpha_F} \mid \overline{\alpha_F}), g(\underline{\alpha_F} \mid \overline{\alpha_F}), g(\overline{\alpha_F} \mid \underline{\alpha_F}), g(\underline{\alpha_F} \mid \underline{\alpha_F}) \right\},$$

where $g(\overline{\alpha_F} \mid \overline{\alpha_F}) + g(\overline{\alpha_F} \mid \underline{\alpha_F}) = 1$ and $g(\underline{\alpha_F} \mid \overline{\alpha_F}) + g(\underline{\alpha_F} \mid \underline{\alpha_F}) = 1$. The term $g(\underline{\alpha_F} \mid \overline{\alpha_F})$ represents the probability of making a mistake by concluding that $\alpha_F = \underline{\alpha_F}$ when the truth is that $\alpha_F = \overline{\alpha_F}$. The term $g(\underline{\alpha_F} \mid \underline{\alpha_F})$ is the probability of correctly predicting that $\alpha_F = \underline{\alpha_F}$. The other probabilities are defined analogously.

Assuming that $g(.|.)$ is known, then after a consultation with the R&R, the parent updates beliefs about the productivity parameter using Bayes rule. Let μ denote the posterior belief that $\alpha_F = \overline{\alpha_F}$. Then, if the parent is told that $\alpha_F = \overline{\alpha_F}$, by Bayes rule $\mu = \rho g(\overline{\alpha_F} \mid \overline{\alpha_F}) / \left(\rho g(\overline{\alpha_F} \mid \overline{\alpha_F}) + (1-\rho) g(\overline{\alpha_F} \mid \underline{\alpha_F}) \right)$. Alternatively, if the parent is told that $\alpha_F = \underline{\alpha_F}$, then

$$\mu = \rho g(\underline{\alpha_F} \mid \overline{\alpha_F}) / \left(\rho g(\underline{\alpha_F} \mid \overline{\alpha_F}) + (1-\rho) g(\underline{\alpha_F} \mid \underline{\alpha_F}) \right).$$

Given posterior beliefs the mother maximizes her expected utility $E_\mu U(F, \alpha_F, \varepsilon)$, choosing $F^*(\mu)$, which yields expected utility $V(\mu)$.

Following Kihlstrom's [5] exposition of Blackwell's [1] sufficiency criteria, for any two information structures g^1 and g^2, g^1 is said to be more informative than g^2

if every utility maximizer prefers g^1 over g^2. More information thus increases the expected value of any convex function of posterior beliefs.

Proposition 2: The expected value of information about child care quality to the parent is positive. In other words, $V(\mu)$ is convex in μ.

Proof: If μ denotes the mother's posterior belief that $\alpha_F = \overline{\alpha_F}$, then by strict concavity of U, $\forall \hat{\mu} \neq \mu \quad V(\mu) > \mu\tilde{U}(F^*(\hat{\mu}),\overline{\alpha_F}) + (1-\mu)\tilde{U}(F^*(\hat{\mu}),\underline{\alpha_F})$. Alternatively, if μ' denotes the posterior belief that $\alpha_F = \overline{\alpha_F}$, then by strict concavity of U, $\forall \hat{\mu} \neq \mu' \quad V(\mu') > \mu'\tilde{U}(F^*(\hat{\mu}),\overline{\alpha_F}) + (1-\mu')\tilde{U}(F^*(\hat{\mu}),\underline{\alpha_F})$. Thus, $\forall \theta \in (0,1)$

$$\theta V(\mu)+(1-\theta)V(\mu') > (\theta\mu+(1-\theta)\mu')\tilde{U}(F^*(\hat{\mu}),\overline{\alpha_F})+(1-\theta\mu-(1-\theta)\mu')\tilde{U}(F^*(\hat{\mu}),\underline{\alpha_F})$$

Finally, let $\hat{\mu} = \theta\mu + (1-\theta)\mu'$. Substituting $\hat{\mu}$ in the equation above yields, $\theta V(\mu) + (1-\theta)V(\mu') > V(\theta\mu + (1-\theta)\mu') = V(\hat{\mu})$.

The value of information to parents about the quality of child care is thus always positive.

THE VALUE OF FULL INFORMATION ABOUT MULTIPLE CHILD CARE ARRANGEMENTS

Now assume that the mother has more than one child care choice. For simplicity, assume that there are two possible child care arrangements (j=1,2), each of which is characterized by a productivity parameter $\alpha_F^j \in \left\{\overline{\alpha_F}, \underline{\alpha_F}\right\}$, and by the mother's prior belief ρ^j that $\alpha_F^j = \overline{\alpha_F}$. Assume that the hourly fee for both arrangements is the same, $P_F^1 = P_F^2 = P_F$, and assume that the mother only employs one of the two arrangements.

The solution to the mother's optimization problem must now be found in two steps. The mother first figures out the optimal number of hours for each arrangement and then chooses the arrangement that yields the highest expected utility. The first step is given by the following optimization problem,

$$\underset{F^j}{Max}\, E_{\rho^j} U(F^j, \alpha_F^j, \varepsilon) = \rho^j\, \tilde{U}(F^j, \overline{\alpha_F}) + (1-\rho^j)\, \tilde{U}(F^j, \underline{\alpha_F}) \qquad (3)$$

where

$$\tilde{U}(F^j, \alpha_F) = \int_E U(\alpha_T(16-F^j) + \alpha_F^j F^j + \varepsilon, 16-F^j, (W-P_F)F^j + Z) f(\varepsilon) d\varepsilon \qquad (4)$$

Let $F^{j,*}(\rho^j)$ denote the number of child care hours that maximizes $E_{\rho^j}U(F^j,\alpha_F^j,\varepsilon)$ and let $V(\rho^j)$ denote the expected utility derived from arrangement *j*. Given curvature assumptions, $F^{j,*}(\rho^j)$ exists and is a unique maximum.

Without loss of generality, assume that $\rho^1 > \rho^2$. As shown in Lemma 1 below, this implies that $V(\rho^1) \geq V(\rho^2)$, and thus that the mother chooses arrangement *j*=1 and expects utility $V(\rho^1)$.

Lemma 1: The mother's value function is non-decreasing in posterior beliefs, i.e. if
$\rho^1 > \rho^2$ then $V(\rho^1) \geq V(\rho^2)$.

Proof: Differentiating $V(\rho)$ with respect to ρ yields,

$$\frac{dV(\rho)}{d\rho} = \left(\tilde{U}(F^*(\rho),\overline{\alpha_F}) - \tilde{U}(F^*(\rho),\underline{\alpha_F})\right) + \left(\rho\frac{d\tilde{U}(F^*(\rho),\overline{\alpha_F})}{dF} + (1-\rho)\frac{d\tilde{U}(F^*(\rho),\underline{\alpha_F})}{dF}\right)\frac{dF*(\rho)}{d\rho}. \quad (5)$$

Given the first order condition of the maximization problem (3), this equation reduces to,

$$\frac{dV(\rho)}{d\rho} = \left(\tilde{U}(F^*(\rho),\overline{\alpha_F}) - \tilde{U}(F^*(\rho),\underline{\alpha_F})\right) \geq 0, \quad (6)$$

which is non-negative given that U is non-decreasing in α_F.

In the absence of a consultation with an R&R (or in the absence of any information) the mother thus chooses arrangement $j=1$ and expects utility $V(\rho^1)$. Now assume that the mother has the option of going to an R&R where she can learn the true quality of each child care arrangement with probability one. Table 1 shows the four possible results of the consultation (called "messages" in the table), the ex-ante probability that the mother assigns to receiving each of these messages, and the optimal post-consultation choice. For example, if the mother learns that $\alpha_F^1 = \underline{\alpha_F}$ and $\alpha_F^2 = \overline{\alpha_F}$, then she chooses $j=2$ and expects utility $V(1)$. Ex-ante she expects to receive this message with probability $(1-\rho^1)\rho^2$. If the mother learns that $\alpha_F^1 = \overline{\alpha_F}$ and $\alpha_F^2 = \overline{\alpha_F}$, she is indifferent between the two arrangements. In either case she expects utility $V(1)$. The probability of this occurrence is $\rho^1\rho^2$. The other scenarios are defined analogously.

Table 1
Possible Counseling Outcomes, And Optimal Fully Informed Choices

Messages	Probability	Fully Informed Decision	Fully Informed Expected Utility
$\alpha_F^1 = \overline{\alpha_F}$ and $\alpha_F^2 = \overline{\alpha_F}$	$\rho^1\rho^2$	Indifferent	$V(1)$
$\alpha_F^1 = \overline{\alpha_F}$ and $\alpha_F^2 = \underline{\alpha_F}$	$\rho^1(1-\rho^2)$	Chooses $j=1$	$V(1)$
$\alpha_F^1 = \underline{\alpha_F}$ and $\alpha_F^2 = \overline{\alpha_F}$	$(1-\rho^1)\rho^2$	Chooses $j=2$	$V(1)$
$\alpha_F^1 = \underline{\alpha_F}$ and $\alpha_F^2 = \underline{\alpha_F}$	$(1-\rho^1)(1-\rho^2)$	Indifferent	$V(0)$

Taking into account all the possible combinations of messages that the mother may receive from the R&R, the expected utility of the mother if she schedules a consultation with the R&R prior to making child care choices is given by

$$\begin{aligned} &V(1)(\rho^1\rho^2 + \rho^1(1-\rho^2) + (1-\rho^1)\rho^2) + V(0)(1-\rho^1)(1-\rho^2) \\ &= V(1)(\rho^1 + \rho^2 - \rho^1\rho^2) + V(0)(1-\rho^1)(1-\rho^2) \end{aligned} \quad . \tag{7}$$

The value of full information to the mother, call it VI^M, is thus given by

$$VI^M = \left[V(1)(\rho^1 + \rho^2 - \rho^1\rho^2) + V(0)(1-\rho^1)(1-\rho^2)\right] - V(\rho^1) \, . \tag{8}$$

Proposition 3: Assume that while at work the mother chooses to place her child in one out of two possible child care arrangements. Then, the value of full information about child care quality to the mother is positive, i.e. $VI^M > 0$.

Proof: Note that VI^M may be written as

$$VI^M = \rho^1 V(1) + (1-\rho^1)V(0) - V(\rho^1) + \rho^2(1-\rho^1)(V(1) - V(0)) > 0 \, . \tag{9}$$

The proof then follows from Proposition 1 and Lemma 1.

Whether there are multiple choices or a single child care choice available to parents, they always value and are willing to buy information about the quality of child care arrangements.

CONCLUSIONS AND EXTENSIONS

The quality of child care arrangements such as day care centers is very important to the development of children, and can vary significantly from arrangement to arrangement. In this paper I study the value of information to parents about the quality of these arrangements using a women labor supply model under quality uncertainty. I find that the value of information about child care quality is always positive. This confirms theoretically the intuitive empirical results from surveyed parents reported by Mocan's [9] survey analysis.

Straight forward extensions of this work include studying the value of information when the mother chooses to place her child in more than one arrangement, and numerical analysis of the models to study how the parent's wages, the productivity of non-parental and maternal care, and child care fees affect the value of information. Such research could help R&Rs to better price their services, and to reach a higher pool of parents.

ENDNOTES

[1] The uncertainty and information literature has generally found that in the absence of strategic considerations, information is always valuable to agents. This is the case for example in Mirman, Samuelson and Urbano [7]. When there are strategic interactions, public information may be harmful to agents, as shown by Mirman, Samuelson and Schlee [8] and Schlee [12] among others.

[2] The assumption of a linear quality production function is not crucial to the analysis. In fact, the results of the model hold for more complex functions as well.

[3] Otherwise, $F(1)$ would not be a maximum.

[4] Otherwise, $F^*(0)$ would not be a maximum.

[5] The exposition of information and Bayesian learning discussed in this paper is based on Drees and Eckert [3], Kihlstrom [5], and in Hirshleifer and Riley [4].

REFERENCES

Blackwell, David, “Equivalent Comparisons of Experiments.” *Annals of Mathematical Statistics* 24 (1953): 265-27

Blau, David M., and Alison P. Hagy, “The Demand for Quality in Child Care.” *The Journal of Political Economy* 106, No. 1 (1998): 104-146.

Drees, Burkhard, and Bernhard Eckwert. “Welfare Effects of Transparency in Foreign Exchange Markets: The Role of Hedging Opportunities.**”** *Review of International Economics* 11, No. 3 (2003): 453-463.

Hirshleifer, Jack, and John G. Riley. *The Analytics of Uncertainty and Information*. Cambridge*:* Cambridge University Press, 1992.

Kihlstrom, Richard E. “A "Bayesian" Exposition of Blackwell's Theorem on the Comparison of Experiments.” In *Bayesian Models in Economic Theory*, edited by Marcel Boyer, and Richard E. Kihlstrom, 13-31. New York: Elsevier Science, 1984.

Michalopoulos, Charles, Philip K. Robins, and Irwin Garfinkel, “A Structural Model of Labor Supply and Child Care Demand.” *The Journal of Human Resources* 27, No. 1 (1992): 166-203.

Mirman, Leonard J., Larry Samuelson, and Amparo Urbano, “Monopoly Experimentation.” *International Economic Review* 34, No.3 (1993): 549-563.

Mirman, Leonard J., Larry Samuelson, and Edward E. Schlee. “Strategic Information Manipulation in Duopolies.” *Journal of Economic Theory* 62, No. 2 (1994): 363-384.

Mocan, Naci H. “Can Consumers Detect Lemons? Information Asymmetry in the Market for Child Care.” (2001), http://ssrn.com/abstract=270201

National Association of Child Care Resource and Referral Agencies. “Poised for Shaping Results-Based Early Learning Systems.” (2003) http://www.naccrra.org/docs/shaping_els-execsum.pdf

Ribar, David C. “Child Care and the Labor Supply of Married Women: Reduced Form Evidence.” *The Journal of Human Resources* 27, No 1 (1992): 134-165.

Schlee, Edward E. “The Value of Information About Product Quality.” *The RAND Journal of Economics* 27, No. 3 (1996): 803-815.

U.S. Census Bureau. “Who’s Minding the Kids? Child Care Arrangements: Spring 1997.” (2002). http://www.census.gov/prod/2002pubs/p70-86.pdf.